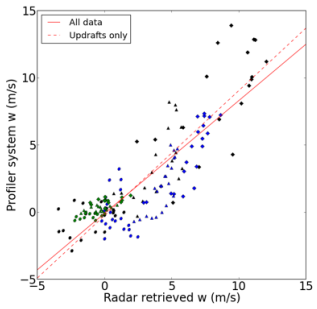
Statistics of Vertical Velocities from Monsoonal Convection with Verification

Research Highlight

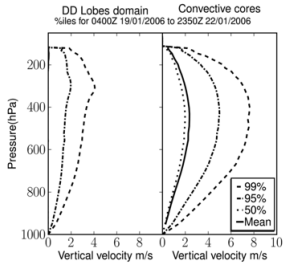
Many studies use fine-scale models of the atmosphere to develop and test sub-grid scale parameterizations of convection in general circulation models (GCMs, also known as climate models). In fact, many experiments, including those run by the ARM Climate Research Facility, supplement observing capabilities with balloon-borne sounding arrays with forcing fine-scale models in mind. Due to issues of scale and safety, it is near impossible to directly measure vertical, or updraft, velocity of deep convective cores, leaving only the option of remote sensing.

The recently accepted paper by Collis et al. uses a pair of scanning 5-centimeter Doppler radars to variationally retrieve three-dimensional (resolved in latitude, longitude, and height) three-component (zonal, meridional and vertical) wind speeds. The study uses a nearby profiling measurement system and an advective technique to check the veracity of the retrieval and then, using more than a thousand radar volumes, reconstructs statistical profiles of vertical velocity over the wet monsoon period of the Tropical Warm Pool-International Cloud Experiment (TWP-ICE) . These profiles are compared to recently published statistics for the same period from the NASA Goddard Weather, Research, and Forecasting (WRF) model, highlighting what many have suspected: the model updrafts are almost a factor of two higher that those observed.

There are several reasons why this may be, and the study speculates it may be due to lack of entrainment in the model, leading to highly undiluted cores, but clearly further work is needed to observationally constrain and understand the processes pertaining to vertical motions in the atmosphere in fine-scale models.



A scatter plot of profiler-derived vertical velocities versus the scanning radar-retrieved vertical velocities. Dots represent minimum values, triangles represent mean values, and diamonds represent maximum values. The solid line is a fit to all maximum, mean, and minimum values, while the dashed line is a fit to maximum values only. The different colors represent the different cases presented in the study with the squall in black, the embedded system in blue, and the cirrus case in green.



Plots of various percentiles of vertical velocities retrieved over the wet monsoon period of TWP-ICE. The left-hand side corresponds to all valid returns in the dual-Doppler lobes, while the right-hand side is a conditional sample for columns that have w >1 m s-1 for at least 5 kilometers of depth. The left-hand side isolates deep convective cores to allow comparison with models.

Reference(s)

Collis S, A Protat, PT May, and C Williams. 2013. "Statistics of storm updraft velocities from TWP-ICE including verification with profiling measurements." Journal of Applied Meteorology and Climatology, , . ACCEPTED.

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Working Group(s)

Cloud Life Cycle